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Literature Review on Study of Structural Behaviour of Bamboo Reinforced Concrete Structures

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ABSTRACT

Bamboo is the one of the material which is used as construction material from ancient times. It was used as reinforcement with mud and as formwork also. Concrete have high compressive strength but has low tensile strength due to this, it is often reinforced with steel bars. In this study we are trying to found out the properties of bamboo from previous research papers.

Key words: Bamboo, mechanical and physical properties, concrete reinforcement.

I. INTRODUCTION

Concrete is mostly used material in building construction. It is used largely because it is economical, readily available, mouldable and has suitable building properties, such as high compressive strength. It has low tensile strength due to this; it is often reinforced with steel bars. These bars provide the high tensile strength to concrete. But use of steel has some disadvantages, like higher cost and non-renewability, corrosion of bars, etc. Production of steel is responsible for a major source of greenhouse gas emission. Hence, many attempts are carried out by researchers to provide a low cost sustainable alternative of steel by using locally available material. Many researchers investigated the possibilities of using vegetables, fibers materials as reinforcement in concrete. Vegetable fibersous materials which have been studied are 1) jute, 2) coconut, 3) coir, 4) sisal, 5) babadua, 6) date palm, 7) raffia palm, 8) bamboo and bamboo fibers, etc. although, most of these studied yielded good results still bamboo has a clear advantages over other natural reinforcing material.

Bamboo is one material, which reaches its full growth in just a few months and reaches its maximum mechanical strength in just few years. It exits abundance in tropical and sub-tropical regions and makes it an economically advantageous a lightweight design, better flexibility, and toughness due to thin walls with discretely disturbed nodes and its great strength make it a good construction material. It is used as structural material for scaffolding at construction sites, building roads, furniture, rugs, diapers, clothes; promote fertility in cows, medical purposes and many more accessories.

II. FEASIBILITY TESTS

To check the feasibility and reliability of using bamboo splint as reinforcement and to select and to prepare the most suitable kind of bamboo specimen to use in concrete as reinforcement. The following tests must be performed before using as reinforcement on different bamboo specimens:-

1. Moisture Content
2. Mass density
3. Shrinkage
4. Water Absorption
5. Tensile Strength
6. Compressive Strength
7. Shear Strength
8. Modulus of Rupture
9. Modulus of Elasticity

III.LITERATURE REVIEW

a) Ali Awaludina, Viki Andriania, "Bolted Bamboo Joints Reinforced with Fibers, 2nd International Conference on Sustainable Civil Engineering Structures and Construction Materials 2014 (scescm 2014), Procedia Engineering 95 (2014) 15 – 21. In this study, connections in bamboo constructions are regarded as the weakest parts and have hindered the optimal utilization of excellent bamboo engineering properties were studied in this work. This paper discussed development of various methods of bamboo jointing, including the authors' proposal where Fiber Reinforced Plastic (FRP) in the form of sheets is used to improve the structural performance of bolted bamboo joints. The test results showed a significant increase of join slip modulus and lateral load capacity of the bolted bamboo connections due to wrapping effects when they are reinforced with FRP sheets, especially the overlap joints.[1]

b) Atul Agarwal, Bhardwaj Nanda, Damodar Maity, "Experimental Investigation on Chemically Treated Bamboo Reinforced Concrete Beams and Columns", Construction and Building materials 71 (2014) 610–617, 26th September 2014.

In this study, the feasibility of usage of bamboo of usage of bamboo as reinforcement in concrete has been evaluated through a series of experiment investigation on of various beams and column. The bamboos were chemically treated. The tests performed on specimens were tensile test on bamboo specimen, pull out test of bamboo slats embedded in concrete, axial load test an d transverse load test on BRC columns and 2 point load test on BRC beams. It is observed from pull out test that the bonding strength of the treated bamboo concrete composite is highest for Sikadur 32 Gel among the other adhesives composed.

From the axial load test it is observed that, the plain concrete and untreated bamboo reinforced concrete show brittle behavior and shows little warning before axial failure whereas treated bamboo reinforced concrete column with Sikadur 32

gel shows ductile behavior and gives warning before failure. It is found that treated BRC column with 8.0% bamboo reinforcement provides same strength and behavior as pra with reinforcement concrete column with 0.89% steel. From all these test we got to know that bamboo has the potential to substitute steel as reinforcement for beam and column members.[2]

c) Bhavna Sharma, Ana Gatóo, Maximilian Bock, Michael Ramage, "Engineered Bamboo for Structural Applications", Construction and Building materials 81 (2015) 66–73, 23rd February 2015.

The expertimental work characterizes the mechanical properties of two types of commercial products: bamboo scrimber and laminated bamboo. The study utilised timber standards for characterization, which allows for comparison to timber and engineered timber products. The results of the study indicate that both products have properties that compare with or surpass that of timber. Bamboo scrimber and laminated bamboo are heavily processed before testing. Future work includes investigating the influence of processing on the material properties. In particular, the impact of heat treatment performed on the material to achieve a caramel color. A comparison study on natural colored bamboo will provide better understanding of the effects of heat treatment on the strength of the material. The beam section can be optimized to take advantage of the high flexural strength to density ratio. Research on the influence of the orientation of the original board on the stiffness will also allow for further optimization. Further investigation of the influence of moisture and the density on the mechanical properties is needed to provide a foundation from which to develop design characterization factors for engineered bamboo. Additional testing of full-scale specimens would also elucidate any effects in comparison to small clear specimens, as well as allow further comparison to timber and provide an additional step forward towards construction.[3]

d) Humberto C. Lima. Jr, Fabio L. Willrich, Normando P. Barbosa, Maxer A. Rosa, Bruna S. Cunha, "Durability Analysis of Bamboo as Concrete Reinforcement", Materials and Structures (2008), published online on 12th September 2007. The experimental work on the bamboo species Dendrocalamus giganteus showed that the bamboo tensile strength is comparable with the best woods used in constructions and even with steel. The tensile stress Vs strain curve of the bamboo is linear up to failure. Bamboo average tensile strength is approximately 280 MPa in the specimens with node. Finally, 60 cycles of wetting and drying in solution of calcium hydroxide and tap water did not decrease the bamboo tensile strength neither the Young's Modolus.[4]

e) Leena Khare, "Performance Evaluation of Bamboo Reinforced Concrete Beams", the University of Texas at Arlington December 2005. This study evaluated the feasibility of the use of bamboo as a potential reinforcement in concrete structural members. To achieve this objective a series of tensile tests were conducted on three types of bamboo followed by four point bending tests of concrete beams reinforced with bamboo. The test results were compared with plain and steel reinforced concrete beams behaviour. Three types of bamboo used were: Moso (China); Solid (South America; and Tonkin (China). Based upon the tests conducted, the following conclusions are at the forefronts:

- The failure loads varied with the compression strength of the concrete, providing a lower failure load for lower compression strengths.
- The beam with 4% Bamboo reinforcement produced an over reinforced failure mode.
- The load carrying capacity of the Moso Bamboo was higher than that of Solid Bamboo. Also Solid bamboo deflected less than Moso indicating that Moso behaved in more ductile manner.
- Tensile tests indicated that presence of nodes in Solid Bamboo samples did not affect the behaviour.
- The constitutive relationship of the nodes differs from those of inter-nodal regions with nodes having a brittle behaviour while inter-nodal regions exhibit a more ductile behaviour
- The waterproofing agent chosen provided poor bonding. Bond-enhancing applications should be required to strengthen the bonding between the concrete and the Bamboo.
- The stirrups were developed using flexible Tonkein Bamboo. The size selected for stirrups was ½ in(13 mm) to obtain flexibility. This stirrups design provided small resistance to shear forces.
- Based on the limited number of testing conducted, it was concluded that Bamboo can potentially be used as substitute steel reinforcement. However, for regions of the world that availability of steel is limited and plain concrete members are commonly being used, the use of reinforced bamboo concrete is highly recommended.
- The breaking patterns of the tensile tests were overall inconclusive. However, there was an indication that the fracture points of the tensile samples containing nodes occurred at the nodes, which was also verified in the beam tests.
- In general, samples failed by: (1) node failure; (2) end tap failure; and (3) failure at the vicinity of the end tap.
- The failure load patterns of the tensile samples were overall inconclusive. However, the samples with nodes generally failed at higher loads than those samples without nodes.[5]

IV.CONCLUSION

From the above literature review we come to know that, bamboo is a natural material, eco-friendly, economical and flexible material. Bamboo must be used in the form of splint and must be treated before using as reinforcement in concrete. As per study we can conclude that bamboo can be used as reinforcement in concrete for low cost construction mostly required in rural areas.

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